VOL. 11, No. 2 FEBRUARY, 1934

The AMERICAN JOURNAL *of* OPTOMETRY

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Published Monthly by the AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION, 1501 Foshay Tower, 821 Marquette Ave., Minneapolis, Minn.

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AMERICAN JOURNAL OF OPTOMETRY

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A M E R I C A N

AMERICAN JOURNAL OF OPTOMETRY

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A NEW PRECISION STEREOSCOPE AND A NEW OBJECTIVE TECHNIQUE FOR INVESTIGATING BINOCULAR PHENOMENA*

Robert H. Peckham, Ph.D.,
Johns Hopkins University, Baltimore, Md.

The problems of binocular vision are of major interest to many groups of investigators. The ophthalmologist and the optometrist are primarily interested in their service to comfortable vision. Physiologists are concerned with the reflexes involved which, even at this late date, and after much patient investigation, are rather obscure. Neurologists have long sought to discover the paths of the nervous innervation of the extrinsic and intrinsic musculature. General physicians depend upon certain analogies of the binocular functions as diagnostic signs.

But to the psychologist the behavior of the pair of eyes is a most interesting subject, if only because of the very baffling nature of the problem. There is an almost unending history of investigation into the perceptual side of binocular vision, and an equally extended and involved history of the overt behavior. This history involves frequent and intimate exchanges of observations and conjectures between philosophers, physiologists and psychologists, with the psychologist gradually taking the lead as being interested in both the perceptual and the behavior aspects.

It has been my purpose to evolve some method to correlate these two sets of data, and thus to find what relations, if any, exist between the perceptual variations of binocular vision, and objective data of the eye-muscle changes.

The most obvious method, although not necessarily the best, is a simultaneous record of perception and of movements of the eyes. The method is not at all new, however novel may be my application. There have been many adequate researches upon the movements of monocular fixation, and occasionally of binocular fixation, by either mechanical or photographic means.

Since the stereoscope, in any of its forms, presents the easiest method of extending the binocular stimuli into separable factors for each eye, and

*(A paper presented at the Annual Meeting of the Southern Society for Philosophy and Psychology, at Washington, D. C., April, 1933.)

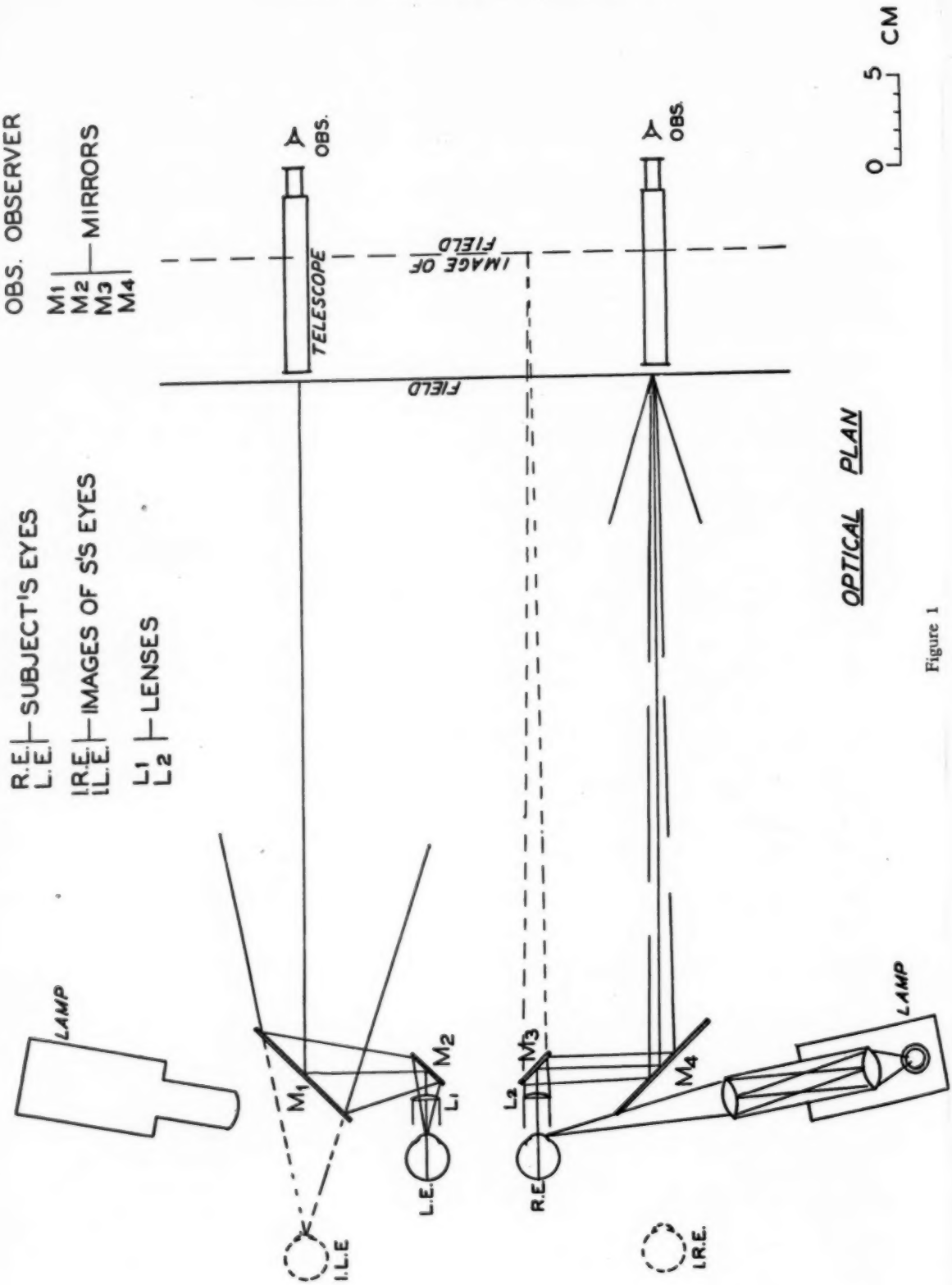

OBS. OBSERVER
MIRRORS
M1
M2
M3
M4
SUBJECT'S EYES
R.E.
L.E.
IMAGES OF S'S EYES
I.R.E.
I.L.E.
LENSES
L1
L2
OBS.
TELESCOPE
IMAGE OF FIELD
FIELD
0
5 CM
OPTICAL PLAN
LAMP
M1
M2
L1
L.E.
I.L.E
M3
L2
R.E
M4
I.R.E.
LAMP

Figure 1

since its forms are so common in physiological, ophthalmological, and psychological procedure, I have used this form of instrumentation as a basis for my investigations.

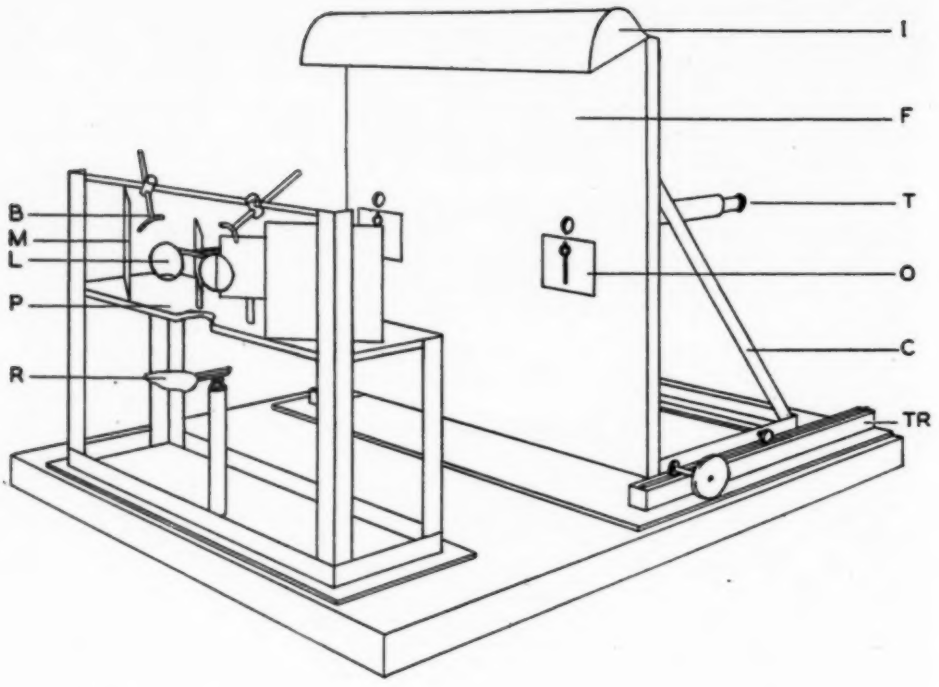
Of the many types, the Wheatstone stereoscope, with its modifications, offers the most adaptable instrumentation. It can be adjusted to any pupillary separation, to any object distance, to any abnormal deviation, and to any desired stimulus-object presentation. By means of such a stereoscope the problems of binocular fixation, of binocular depth perception, of binocular color perception, and of retinal rivalry, can be resolved into the forms and positions of stimulus-object presentation, in as far as the method of stimulation has a part in the resultant perception.

If we can add to such a stereoscope an objective means of recording behavior changes, it may be possible to find the correlations between the perception and the ocular movements.

A Wheatstone stereoscope has therefore been constructed that would fulfill the requirements of both the extension of the stimulus-objects with accuracy of optical path, and means for observing eye-movements. This drawing shows the optical plan of the instrument. The two eyes of the subject, marked R. E. and L. E., receive light from the stimulus objects in the plane of the field. This light has been reflected by the four mirrors, a pair for each eye, so that the light is reflected as coming from the position indicated as "image of the field." When the mirrors and the objects are properly placed, rays of light from the objects will enter the eye from a point directly in front of each respective eye. A lens, marked L., is placed in the path of this beam, and is of such focal length that the divergent light from the object is rendered parallel. The optical centers of these lenses are maintained at the pupillary separation of the subject. It is therefore apparent that the light from both stimulus-objects is coming from a virtual infinity. Two telescopes are placed in back of the field, through which the observer watches the eyes, and small holes are cut in the field board to accommodate these telescopes. The observer sees the eyes, through these telescopes, as magnified images of the reflected images I. R. E. and I. L. E.

Two lamps are placed at the sides to illuminate the subject's eyes. These lamps are built on the principle of the optical relay, so that they project a brilliant spot about two inches in diameter, flooding the eye tangentially, and causing as little annoyance to the subject as any possible arrangement of adequate illumination, since very little of this light enters the pupil and strikes the retina. But because of the curvature and refraction of the cornea, this light effectively illuminates the whole iris.

The following dimensions apply to the particular instrument constructed at Johns Hopkins: the separation of the stimulus objects is 200 mm., the optical path is 500 mm., and the magnification of the telescope is 3 diameters.



B — BROW REST
M — MIRROR
L — LENS
P — MIRROR PLATE
R — CHIN REST
I — FIELD ILLUMINANT
T — TELESCOPE
O — OBJECT
C — FIELD CARRIAGE
TR — TRACK FOR CARRIAGE

Figure 2

Figure 2 shows the perspective view of the completed instrument, without the lights and their standards. Certain construction details are apparent. The mirrors are mounted on a rigid frame, which is in turn mounted on a heavy soap-stone base. The vertical field is mounted on a rolling carriage, so that the changes in the optical distance due to the pupillary separation of the subject can be accomplished. The carriage bears two telescopes focussed approximately along the visual axes. The field is maintained at a constant illumination by the reflector attached to the top of the carriage.

The stereoscope has been mounted on a specially built angle iron table, provided with casters and stops, thus adequately supporting the

rather heavy mechanical arrangement so necessary to rigid and accurate construction. The whole set-up weighs about 150 pounds.

Here is a picture of the finished stereoscope. The spot lights for the eyes are seen at each side of the subject directed upon his eyes. The subject is seated so that he is able to draw or trace upon the stimulus object of one side.

By changing the arrangement of the mirrors the stereoscope can be quickly convetred into a pseudoscope of the double Stratton type, as shown in Figure 4. By this arrangement it will be possible to find what changes in binocular perception or in ocular movement are due to the right-right and left-left relations between handedness and eyedness, as well as to study the effects of disparate images in stereoscopic and pseudoscopic vision.

The errors in construction have been very small. As far as possible, each part has been made independently variable in the designing of the instrument, to accommodate for mechanical errors. By using an optical situation similar in principle to the surveyor's transit the angles of the mirrors have been adjusted to within a projected error of 5 cm. at 200 feet. Such an error, translated into angular error at the mirrors, is less than one second of arc. Glass mirrors are used, obtained from the Bausch and Lomb Optical Company made of thin filter "B" glass, silvered on the back, coppered and painted. They are sufficiently well polished for this purpose.

The maximum possible error of the stereoscope, due to lining up, subject's pupillary distance and inaccuracies of compensation for it, temporary disturbances of the lens or possible irregularities of the carriage wheels, is at most an error at the field of 0.25 mm., which amounts to an angular maximum error of 0° 17′ 5″. This is within the closest fixation of the subject. And yet it is interesting to note that some subjects have complained that the instrument was not accurate because their perception did not agree with what they thought it should!

The limit of accuracy of the telescope images of the subjects' eyes is in the same order, subject to the spherical abberation of the telescopes. The present telescopes magnify three diameters, and the least noticeable movement that is not ambiguous to the observer is about 0.10 mm. at the cornea. This corresponds to a fixational change of 4.8 mm. at 500 mm. I have often observed movements of as much as 3 and 4 mm. at the cornea, which would amount to about 80 mm. at the field, and yet the subject did not complain of either diplopia or blurred vision.

The stereoscope is equipped with four telegraph keys, one for each of the subject's hands, and one for each telescope and observer. One observer watching either of the subject's eyes alternately, or two observers, may thus record their observations of movements on a polygraph, at the same time that the subject records his perceptual changes. These records are, of course, subject to the reaction time lag of the individuals.

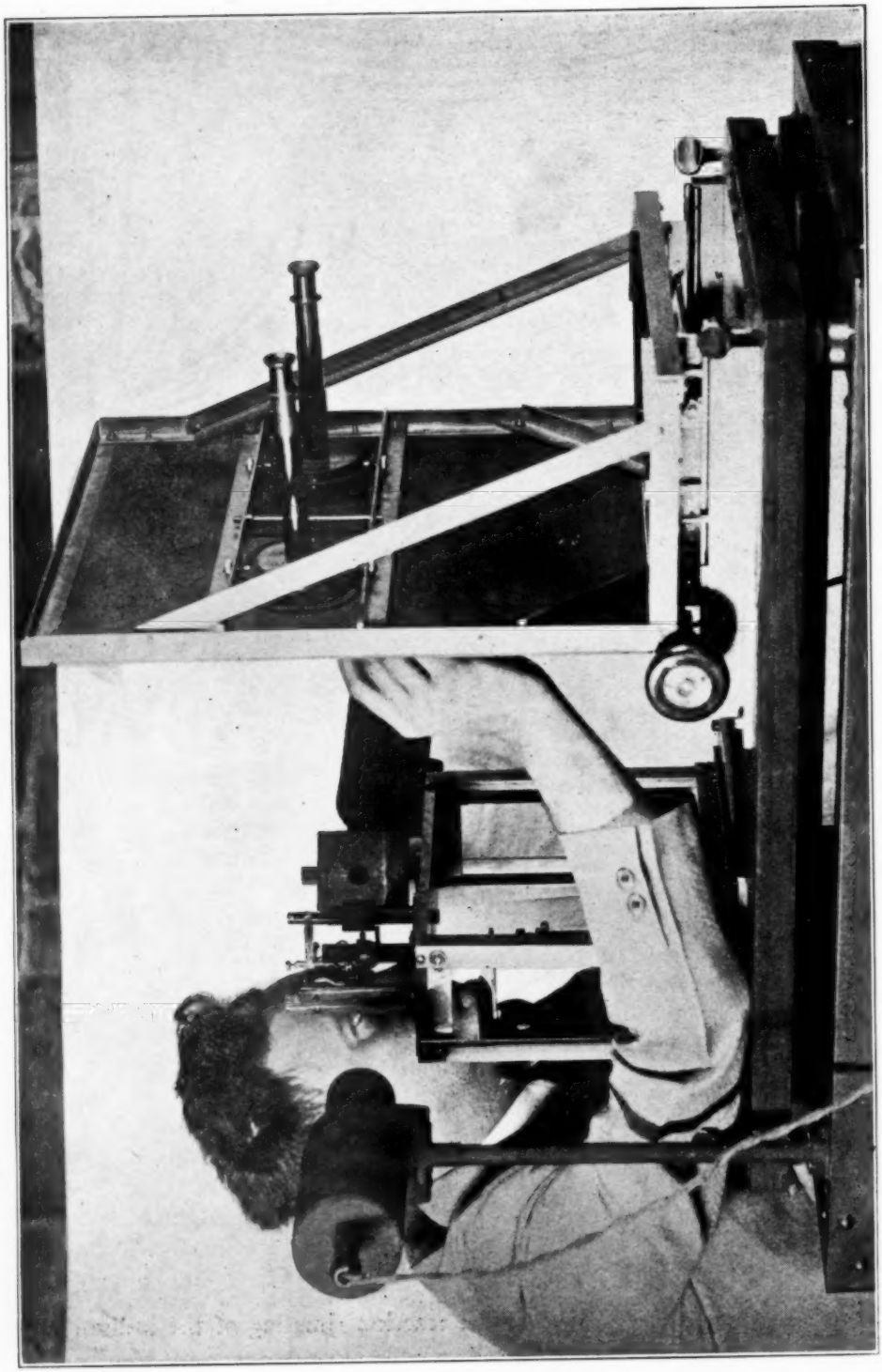
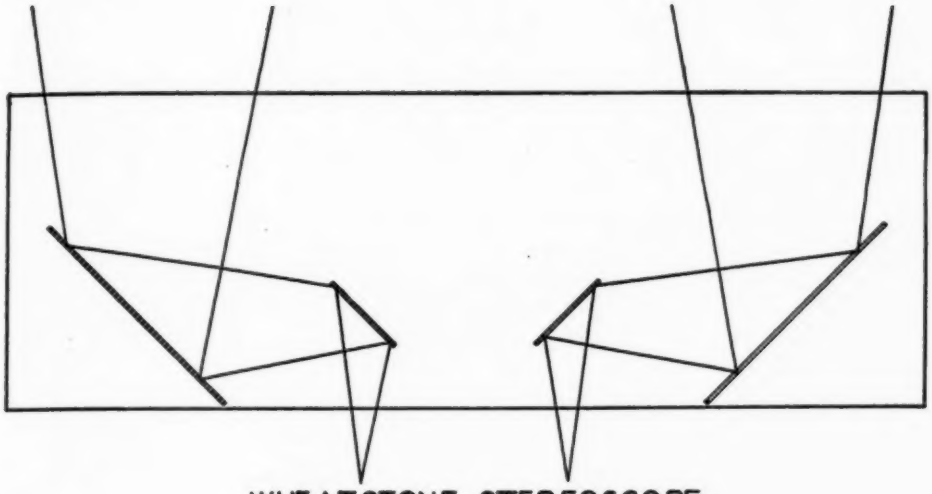
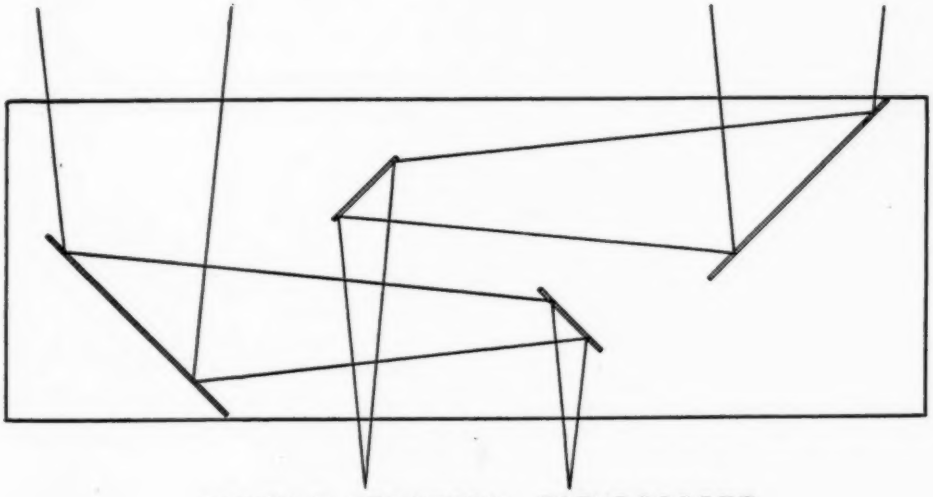


Figure 3



WHEATSTONE STEREOSCOPE



DOUBLE STRATTON PSEUDOSCOPE

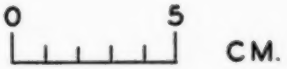


Figure 4

We are at present constructing a method of photographing the iris with an ultra speed moving picture camera to add a more objective check to the present records.

There is not time in the presentation of this paper to discuss the problems under investigation and the present status of our results. We can only state that our primary interest has been centered upon the study of a particular controlled type of binocular rivalry, to ascertain whether there are movements at the time of the perceptual changes, and whether these movements, eye-hand co-ordinations, or some unknown central factors play the most important role in the production of the perceptual changes during the rivalry.

The method, obviously, is not at all limited to the problem I have just outlined. The whole gamut of problems relating to binocular perception must be subjected to the objective scrutiny of this or similar studies, to determine the validity of past conjectures. The questions of binocular color fusion, of alternating or varying monocular color fatigue, of foveal and peripheral stimulation, of cyclotorsion when the stimulus objects are rotated with respect to each other, the study of stereoscopic and pseudoscopic projection and perception, can be investigated by this technique. The theories of identical and of corresponding points must be attacked, since too frequently the objective records found by this method have raised the question of justification of previous assumptions. Thus all the explanations founded upon the assumption of a geometric image-object correspondence must be examined and, if necessary, expanded, to include the factual data of objective technique.

Considerable data may be had from the study of the abnormalities of the ophthalmologists' and optometrists' clientele. Perhaps we can eventually add to the usually subjective tests some definite objective technique for diagnosis and prognosis.

Eye movements during changes of fixation from one distance to another nearer to or farther away; eye movements during reading, or other occupation in which changes of fixation must be made regularly or irregularly; eye movements during phoria and duction tests; eye movements with changes of lens prescriptions where, according to subjective techniques now in use, changes in phorias follow; fixation positions with prism prescriptions; eye movements and fixation positions in strabismic cases; all these and others may be studied with this apparatus.

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ROCHESTER, N. Y.

A STUDY OF THE EXTRINSIC MUSCLES OF THE EYE*

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and
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The study of the anatomy of the ocular muscles has been sadly neglected and upon searching we realize the scarcity of literature on the subject. Anyone who attempts to make dissections of the ocular muscles will find suggestions as to modern appliances and modern technique very helpful. In view of the fact that there are so many possible ways in which the contents of the human orbit may be exposed we shall endeavor to give the methods which have proven most satisfactory for us.

(A) The removal of the orbital contents. The procedure is as follows:

First. Remove the calvaria. In doing this be sure to make the cut low on the frontal bone as it facilitates the removal of the brain.

Second. Remove the brain, clipping the nerve roots close to the dura.

Third. With a pair of bent or curved dissecting forceps separate the dura from the bone around the optic foramen and the supra-orbital fissure, being sure to get as deep into the orbit from behind, as possible.

Fourth. Dissect carefully the structures around the margins of the orbits. Two incisions are made, one at the inner canthus and one at the outer, through the Orbiculars Oculii. The superior portion is turned up and the lower portion down. With a scalpel outline the margin, cutting through the periostia.

Fifth. With a scalpel or dissecting forceps separate the periosteum from the bone. This step should prove very easy, for with the exception of two points, namely, the origin of the Inferior Oblique and the lacrymal duct, the periosteum is only loosely attached to the bone.

Sixth. In this manner follow the periosteum back to the apex of the orbit. A little difficulty will be found in removing the periosteum

*An abridgement of the material presented before the American Academy of Optometry at Chicago, December 19, 1932.

from the margins of the Inferior Orbital canal and fissure. This can most easily be accomplished by the use of a small crooked-neck pair of scissors.

Seventh. If all of the above steps have been carried out carefully there will be no injury to any of the muscles or any part of the orbital content and the structures may be removed intact. If, however, there is any adherence of the periosteum to the bone, either at the foramen or the fissure, dissection should be carried on carefully and slowly until the structures are freed. With the contents thus removed, dissection may be carried on outside of the orbit.

(B) Removal of the orbital contents with the lids and the bone at the apex. The procedure is as follows:

First. Remove the calvarium, being sure to make the cut low over the frontal bone.

Second. Remove the brain, clipping the nerve roots close to the dura.

Third. With a fine chisel chip the bone around the orbital fissure, leaving a small ring of bone around the optical foramen.

Fourth. Dissect carefully the structures around the margins of the orbits. (If the specimen is not to be saved, a deep incision may be made through the Orbicularis Oculii and structures down to the periostium.)

Fifth. Outline the periosteum around the margins of the orbit and with the dissecting forceps or a scalpel separate the periosteum from the bone.

Sixth. Proceed as before until the periosteum is loosened to the apex.

Seventh. If the steps have been carefully carried out, the orbital contents will come out easily with a small ring of bone around the optic foramen. This ring can be easily chipped away, exposing the fibrous ring of Zinn.

Preserving Fluids. It is almost impossible to keep a fresh specimen from decomposing before the dissection is made. The following preparations are very useful in fixing and hardening.

(A) For fixing, the following may be used:

Formalin	200 c. c.
Water	1000 c. c.
Postassium Nitrate	15 grams
Postassium Acetate	30 grams

The specimen should be left in this solution for four to six days.

(B) A solution of pure Formalin may be used but care must be used and the specimen should not be allowed to remain in the bath over ten to fifteen hours.

Injecting Fluids. A simple fluid can be used.

Gelatine	25 grams
Water	100 c. c.

If measurements or data are to be taken from the specimen within twenty-four to thirty-six hours after dissection is made, a pure Formalin fluid can be used.

Before dissection of the contents of the orbit is begun, the anatomy of the muscles should be studied and cuts from some good text gone over carefully, in order to get the relations of the structures in mind as well as possible.

Inflation of the Globe.

Immediately after death the cornea becomes depressed and the globe loses its tonicity, the intraocular tension decreases and the globe with its surrounding structures gradually shrink. So in all specimens it is necessary to inflate the globe in order to regain its normal relations. Especially is this true of cadavers which have been frozen or have remained in the vats for an extra long period. Three or four methods of inflation have been used by the writers, two of which may be easily carried out and are quite successful.

Method One—The optic nerve with its sheath is carefully picked up and long hypodermic needle of about twenty caliber is passed along the nerve to the globe. Before the globe can be penetrated, the needle meets with considerable resistance as the lamina cribosa is reached. This can be overcome by giving the needle a slight rolling movement. To the needle is then attached the syringe and enough pure Formalin is injected to give the globe its normal tension.

Method Two—A hypodermic needle of fine caliber is introduced on a diagonal into the posterior chamber. Be sure the injection is made on a slant as it is then that the internal pressure closes the opening made by the needle and the internal fluids cannot escape. After the dissection has been finished and before any measurements are taken, it may be necessary to reinflate the globe; in case it is necessary the above method is recommended.

Tendinous Origins at the Apex of the Orbit.

Five of the six external muscles of the eye originate at the fibrous ring of Zinn. With the exception of the Inferior Rectus, which originates from the periosteum on the floor of the anterior portion of the orbit, the muscles take their origin at the apex. The tendinous ring of Zinn, also called Annulus Tendineus Communis, from which most of the muscles take their origin, adheres tightly to the margins of the orbit. The ring is divided into two smaller rings in the form of a figure eight, the upper part which surrounds the optic nerve and from which the Superior Rectus and the Medial Rectus spring and the lower half from which the Inferior, Lateral and part of the Superior Oblique muscles take their origin. Through this lower half runs the Oculomotor nerve which is the chief enervator of the orbit. The Superior Rectus has probably the largest origin and afterward comes the Lateral Rectus which arises from two heads, both on the lower rim. The Inferior Rectus, while apparently of small origin, gets a slip from below the Superior Orbital Fissure. The muscle fibers arising from this ring

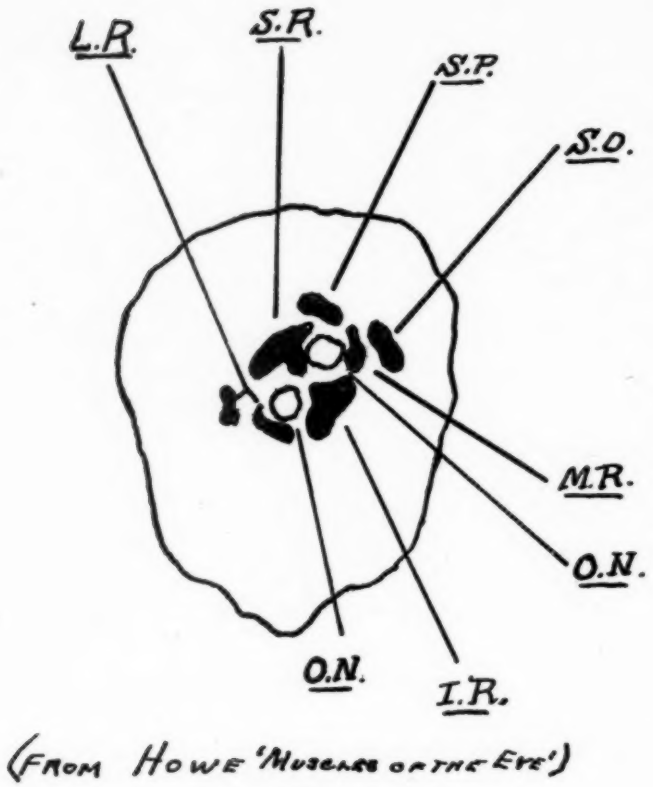


Fig. 1.

actually get slips from the dura which tightly surrounds the Optic and the Oculomotor Nerves as well as the vessels which supply the orbit.

Superior Rectus—The Superior Rectus arises from the tendinous ring of Zinn, on the Superior nasal margin of the optic foramen. It receives slips from the dura of the nerve as well as from the Tendineus Communis. It runs forward and upward in close proximity to the roof of the orbit. Running just beneath the Superior Palpebri and a little lateral to the Superior Oblique, it attaches approximately 7.91 m.m. behind the cornea. On its outer edge lies the superior orbital nerve and the ophthalmic nerve and vessels lie in close proximity as does the ophthalmic branc of Five. This muscle, although fairly round at its origin, plays out into a thin, ribbon-like band, measuring about 9 m.m. across at its widest part. As it reaches its insertion it is encapsulated by the tendinous capsule of the Superior Palpebri and the action of these two muscles are closely associated. This muscle,

although the weakest of the ocular muscles, is the longest and its tendinous insertion longer than any of the others, measuring about 10.8 m.m., giving a total length to the muscles of about 54.3 m.m.

Inferior Rectus—The Inferior Rectus arises from the Inferior nasal quadrant of Zinn's tendon on the inferior margin of the optic foramen. At first the muscle is round but soon plays out into a thin ribbon-like band, and if section in the middle forms an ellipse, as it nears its primary insertion, it becomes covered with dense fatty tissue and finally piercing its capsule, broadens out into a fibrous insertion. A difference may be drawn at this time between the primary and the secondary insertion of the muscles. The primary insertion being, in the opinion of most writers upon the subject, the main insertion of the muscles into the sclera; the secondary insertion being those given by the muscle, to other muscles, tissues or to the periosteum, before reaching its primary insertion. It is these secondary fibers, when united with the secondary fibers of the Inferior Oblique muscle, pass forward and downward to form the "suspensory ligament." The Inferior Rectus is, in its almost entire length, in close proximity to the Internal Rectus. It is inserted about 5.8 m.m. behind the cornea, the length of its insertion being about 10 m.m. The total length of the muscle is about 49.8 m.m.

Lateral Rectus—The Lateral Rectus arises from two fasciculli, one from the lateral part of the Tendon of Zinn and the more medial one from the fibrous sheath of the Optic Nerve. This muscle is unlike any of the other Ocular Muscles, in the fact that it has two definite muscular heads, taking rise in the upper part of the Supra-Orbital fissure, and it is between these two heads that the Third, Sixth and the Nasal branch of the Fifth Nerve make their entrance into the orbit. These heads join immediately and with the heads of the five other ocular muscles originating at the apex, form the muscle cone of the optic foramen. This muscle passes forward and slightly upward, coursing in the most part parallel to the optic nerve. On its medial wall runs the sixth nerve until it reaches about the middle of the muscle, where it is crossed by the lacrymal artery and then dips into the muscle. The muscle is covered by a large amount of fat and anteriorly, near its insertion, it is partially covered by the lacrymal gland. The Lateral Rectus is one of the longest muscles and its insertion not as broad as any of the other recti muscles. It is usually considered as the third muscle in the spiral ring attachments of the four principal recti. The secondary attachments of the external have two general insertions, the first set, broader and wider than the others, attaches to the Orbicularis Oculi, while the second set insert into the later check ligament. According to Volkman, Fuchs and Schneller, the thickness of this muscle is in the ratio of two to three, to its antagonistic muscle, the Internal Rectus. However, the measurements of any given set of specimens is always subject to argument, due to the different methods of fixing and preparation and so any data given may be subject to a difference of opinion. The following measurements are the

average of a great many specimens as are those given throughout this paper: Length 52 m.m., breadth 8 m.m., point of insertion 7.3 m.m. behind the cornea.

Internal Rectus—The Internal Rectus, or Medial Rectus as it is often called, arises from the inferior-nasal border of the ligament of Zinn, and is at its origin in close proximity to the Superior Rectus. Frequently there is an overlapping of the fibers of the Internal, the Oblique and the fibers of origin of the Superior Rectus, and it is only by very close dissection that the real origin of these muscles can be traced. Clinically, the Internal is one of the most important, and anatomically it is the strongest and next to the Superior in length.

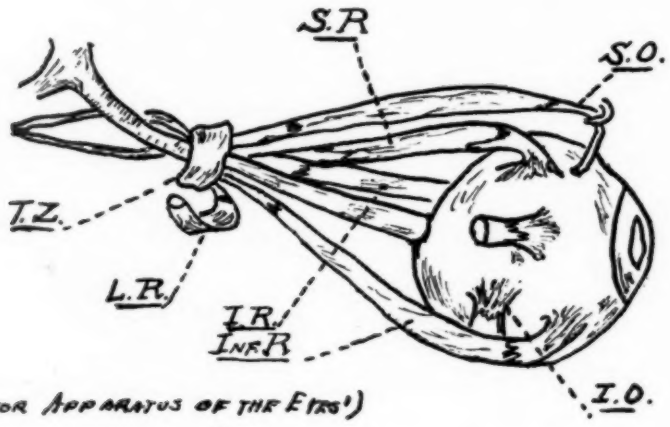
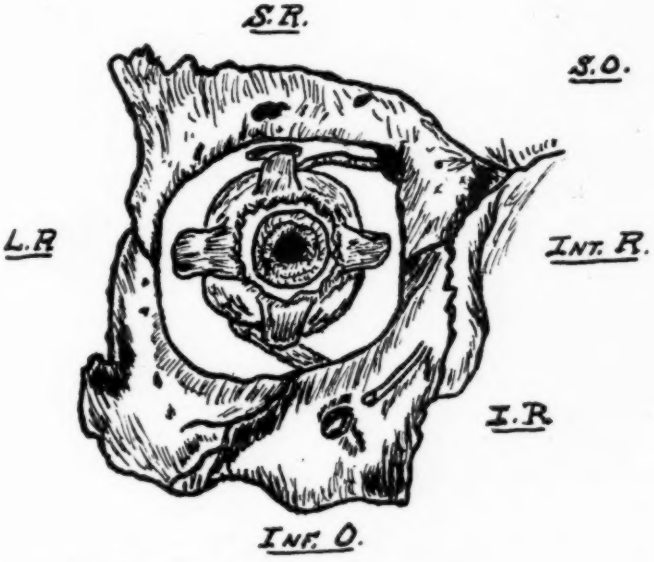


Fig. 2.

It passes forward and slightly upward opposite the External and closely follows the nasal wall of the orbit. It is in close proximity to the Superior Oblique during the first part of its course until the Superior bends sharply upward to pass through the Trochlear Pulley. The Internal is separated from the optic nerve by a thick cushion of fat, through which penetrates a branch of the third nerve which pierces the belly of the muscle 5 to 7 m.m.'s from its origin. It reaches the eyeball at the equator and continues, emerging from the Capsule of Tenon, and inserts into the globe at a distance of about 6.8 m.m. behind the border of the cornea. The principal insertion is usually either a straight line or forms a slight curve with the convexity forward. The middle of the insertion of the Internus is usually below the horizontal line and in some cases two-thirds of the insertion is below the meridian while the External Rectus more frequently varies by having the greater part of its insertion above the meridian. The line also may be inclined a little upward or downward but more frequently the first. The posterior fibers of the secondary insertion blend with the

fibers of the fascia orbito-ocularis and into the Capsule of Tenon; the anterior fibers pass forward and help in forming the medial check ligament. The following measurements are given: Length 48 m.m., breadth, 9 m.m., point of insertion 6.7 m.m. behind the cornea.

Superior Oblique—The Superior Oblique arises from the Zonula of Zinn, between the origin of the Rectus Internus and the Superior Rectus, having its course forward and inward toward the superior-internal angle of the orbit, where it becomes a round tendon in passing through its tendinous pulley, the Trochlea. The Trochlea is a fibrous extension of the periosteum, situated at the Trochlear Fossa of the frontal bone. It is lined by a synovial membrane. From the pulley



(FROM FUCHS' TEXTBOOK OF OPHTHALMOLOGY)

Fig. 3.

the tendon changes its direction, running downward, outward and backward, forming an angle with its former direction of about fifty degrees. It expands again into a flattened band, passing under the Superior Rectus, where it takes its insertion from 1 m.m. to 9 m.m. behind the equator on the posterior-superior lateral quadrant of the eyeball. The relations of this muscle are not especially important, though it is crossed posteriorly by the ophthalmic artery and anteriorly by the supra-orbital branches of this vessel. The line of the primary insertion is usually in the form of a curve, with its convexity lateralward and backward. The length of this insertion varies from 8 m.m. to 10 m.m. The secondary insertions of this muscle are numerous

and may be divided into two classes, those coming off before the pulley is reached and those branching off after the muscle leaves the Trochlea. The first set terminate in the surrounding tissues while the second group terminate in the tissues of the globe and there is a slight line of demarkation between the primary and the secondary insertions. The following data is given: Length 58.7 m.m., breadth 9 m.m., point of insertion is 12 m.m. behind the cornea.

Inferior Oblique—The Inferior Oblique is the only one of the extrinsic muscles which does not take its origin at the apex of the orbit. This muscle, the smallest and the shortest of the eye muscles, arises from a shallow fossa on the orbital plate of the maxilla. If we run our finger over this part of the orbital floor near the anterior border of the lacrymal bone, we can easily feel the depression. The Inferior Oblique arises mostly from the periosteum, although receiving a few fibers from the Capsule of Tenon, and as it passes outward and upward, passing the Inferior Rectus to the inferior side, it receives a few slips from the capsule of that muscle. In doing a section of the orbit, the Inferior Oblique is most easily picked up by passing a curved forcep beneath the periosteum of the lateral wall and proceeding downward and inward. The nose of the forceps will catch at the origin of this muscle. At its origin the Inferior Oblique is round and thick, but as it passes upward and inferior to the Inferior Rectus it becomes a flattened band and at its insertion has attained a width about six times that of its origin. As this muscle passes beneath the Inferior Rectus, it gives off fibers to the sheath of that muscle and the two become quite coherent. It also sends fibers to the orbito-ocularis. As it nears its primary insertion it spreads out much to the posterior and as the final fibers of the insertion grade into the bulber tissue, the posterior slip approaches the optic nerve. The following measurements are given: Length 30.6 m.m., width 4 m.m., and its primary insertion from 2 m.m. to 10 m.m. behind the equator.

Primary Insertions—In order to make any data obtained usable, it must be given collectively as well as separately in order that a clear comparison may be drawn. The following figures are the results of the dissection of twenty-eight specimens. The observations are given for comparison.

	Fuchs	Weiss	Adachi	Howe	Hall and Wittlig
Internal Rectus	5.5	5.85	5.5	5.7	6.09
Inferior "	6.5	6.85	6.8	6.7	6.76
External "	6.9	6.75	7.3	7.4	7.30
Superior "	7.7	8.01	8.3	7.6	7.62

(The above measurements are the average of the distances of insertions from the edge of the cornea in m.m.)

These measurements of course differ in different eyes and in eyes of different anteroposterior dimensions. But if the averages drawn are from normal emmetropic eyes, the Spiral Line of Volkeman may be translated into the following diagram:

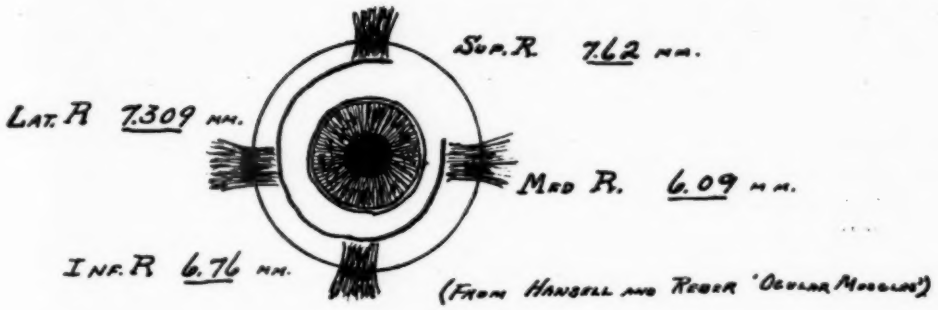


Fig. 4.

The Internal Rectus lies closest to the corneal limbus, the Inferior, second, the External, third, and the Superior, farthest away. This fact is often ignored by some writers while others consider it an important factor in all ocular movements. The breadth as well as the position on the globe may be compared in the following table:

	Fuchs	Weiss	Adachi	Hall and Wittlig
Internal Rectus	10.3	10.76	9.9	10.57
Inferior "	9.8	10.35	9.0	9.94
External "	9.2	9.67	8.4	9.81
Superior "	10.6	10.75	10.0	11.12
Superior Oblique				10.95
Inferior "				9.9

(The above measurements are the average of the breadths of insertions.)

	Distances from Cornea	Breadth of Insertion
Superior Rectus	7.62	11.12
Inferior "	6.76	9.94
Medial "	6.09	10.57
Lateral "	7.309	9.81
Superior Oblique		10.95
Inferior "		9.9

In the following pages are given the list of cases and data obtained from 28 specimens. Due to the fact that warm weather set in, the work had to be abandoned, but will be taken up again in the fall. A few very interesting pathological cases were found and examined. A pair of glaucomatous eyes were removed and during the whole dissection retained their increased tension and hardness. One was removed in which the anteroposterior diameter measured 29 m.m. In one pair large embolii were found in all the arteries and veins, the Recurrent Lacrymal had obtained the size of a little finger and the pressure exerted on the

surrounding tissue had almost entirely destroyed the paparacea of the ethmoid and the muscles crowded over to the lateral side of the orbit.

CASE I.

Length	O. D.	O. S.
Superior Rectus	49.5	50.
Inferior "	46.	45.
Medial "	44.	42.
Lateral "	49.	47.
Superior Oblique		58.
Inferior "	29.	28.
Insertion	O. D.	O. S.
Superior Rectus	8.5	8.
Inferior "	7.	7.5
Medial "	6.	5.
Lateral "	8.5	7.5
Superior Oblique (behind meridian)	–1–8	–5–7.5
Inferior "	–2–10.5	–1–8.
Breadth of Insertion	O. D.	O. S.
Superior Rectus	12.	12.
Inferior "	9.5	9.5
Medial "	12.5	11.5
Lateral "	10.5	10.0
Superior Oblique	9.	11.
Inferior "	9.	9.
Globe Dimensions	O. D.	O. S.
Anteroposterior	24.	25.
Lateral	25.	24.
Vertical	23.	25.
Pulley to Insertion	O. D.	O. S.
Superior Oblique	20.	20.

CASE II.

Length	O. D.	O. S.
Superior Rectus	45.	48.
Inferior "	41.	44.
Medial "	41.	38.
Lateral "	45.	45.
Superior Oblique	59.	58.
Inferior "	31.	29.
Insertion	O. D.	O. S.
Superior Rectus	9.	8.
Inferior "	7.	8.
Medial "	6.	5.5
Lateral "	7.5	7.
Superior Oblique (behind meridian)	0–7.5	0–8.5

Inferior "	–3.8–10.5	–1–8.5

Breadth of Insertion	O. D.	O. S.
Superior Rectus	9.5	11.
Inferior "	9.5	9.
Medial "	11.5	10.5
Lateral "	8.5	9.
Superior Oblique	11.	10.5
Inferior "	8.	8.5

Globe Dimensions	O. D.	O. S.
Anteroposterior	23.	23.
Lateral	23.	23.
Vertical	23.	23.

Pulley to Insertion	O. D.	O. S.
Superior Oblique	21.	20.

CASE III.

Length	O. D.	O. S.
Superior Rectus	55.	56.
Inferior "	54.	55.
Medial "	53.	55.
Lateral "	56.	58.
Superior Oblique	58.	58.
Inferior "	28.	34.

Insertion	O. D.	O. S.
Superior Rectus	7.5	7.5
Inferior "	7.	6.5
Medial "	6.	6.
Lateral "	7.5	7.
Superior Oblique (behind meridian)	0.–8.	4.–5.
Inferior "	2.–5.	–9.

Breadth of Insertion	O. D.	O. S.
Superior Rectus	10.	11.
Inferior "	9.	11.5
Medial "	10.	11.5
Lateral "	10.5	9.5
Superior Oblique	13.	10.5
Inferior "	10.5	12.

Globe Dimensions	O. D.	O. S.
Anteroposterior	24.	24.
Lateral	25.	25.
Vertical	25.	25.

Pulley to Insertion	O. D.	O. S.
Superior Oblique	22.	20.

CASE IV.

Length	O. D.	O. S.
Superior Rectus	57.	57.
Inferior "	54.	56.
Medial "	53.	54.
Lateral "	56.	56.
Superior Oblique	63.	65.
Inferior "	37.	36.

Insertion	O. D.	O. S.
Superior Rectus	8.	8.5
Inferior "	6.	7.
Medial "	7.5	7.
Lateral "	7.5	7.5
Superior Oblique	–1 –9.	–4 –10.
(behind meridian)		
Inferior "	–2 –12.	–4 –11.

Breadth of Insertion	O. D.	O. S.
Superior Rectus	11.5	11.5
Inferior "	9.	10.
Medial "	9.5	9.5
Lateral "	11.	9.
Superior Oblique	9.5	12.
Inferior "	9.	10.

Globe Dimensions	O. D.	O. S.
Anteroposterior	26.	26.
Lateral	25.	26.
Vertical	25.	26.

Pulley to Insertion	O. D.	O. S.
Superior Oblique	20.	23.

CASE V.

Length	O. D.	O. S.
Superior Rectus	55.	54.
Inferior "	57.	55.
Medial "	50.	52.
Lateral "	58.	55.
Superior Oblique	54.	52.
Inferior "	27.	35.

Insertion	O. D.	O. S.
Superior Rectus	7.5	7.5
Inferior "	6.	7.
Medial "	6.	6.
Lateral "	7.	7.5

Superior Oblique	–2 –8	–2 –10.
(behind meridian)		
Inferior "	–1 –12.	–5 –11.
Breadth of Insertion	O. D.	O. S.
Superior Rectus	10.5	10.
Inferior "	10.	11.
Medial "	11.	9.5
Lateral "	10.	8.5
Superior Oblique	7.	10.
Inferior "	11.	10.
Globe Dimensions	O. D.	O. S.
Anteroposterior	29.	24.
Lateral	24.	24.
Vertical	25.	24.
Pulley to Insertion	O. D.	O. S.
Superior Oblique	22.	20.

CASE VI.

Length	O. D.	O. S.
Superior Rectus	57.	58.
Inferior "	49.5	50.
Medial "	47.	47.
Lateral "	52.	51.
Superior Oblique	60.5	58.
Inferior "	33.	30.
Insertion	O. D.	O. S.
Superior Rectus	7.	8.
Inferior "	6.	6.5
Medial "	6.	7.5
Lateral "	7.5	8.
Superior Oblique	–3 –9.	–5 –9.
(behind meridian)		
Inferior "	–4 –12.	–4 –11.
Breadth of Insertion	O. D.	O. S.
Superior Rectus	14.	12.
Inferior "	12.	10.5
Medial "	11.	10.
Lateral "	11.	12.
Superior Oblique	14.	14.
Inferior "	10.	10.5
Globe Dimensions	O. D.	O. S.
Anteroposterior	24.	24.
Lateral	25.	25.
Vertical	25.	25.
Pulley to Insertion	O. D.	O. S.
Superior Oblique	19.5	21.

CASE VII.

Length	O. D.	O. S.
Superior Rectus	51.	53.
Inferior "	52.	53.
Medial "	49.	48.
Lateral "	51.	53.5
Superior Oblique	60.	60.
Inferior "	33.	29.

Insertion	O. D.	O. S.
Superior Rectus	7.5	5.
Inferior "	7.5	7.5
Medial "	6.	7.
Lateral "	7.	8.
Superior Oblique	0 –8. (behind meridian)	–2 –8.
Inferior "	0 –10	–4 –10.

Breadth of Insertion	O. D.	O. S.
Superior Rectus	11.	11.5
Inferior "	10.	10.5
Medial "	10.	10.
Lateral "	9.	9.
Superior Oblique	9.	11.
Inferior "	10.	11.5

Globe Dimensions	O. D.	O. S.
Anteroposterior	25.	24.
Lateral	25.	25.
Vertical	25.	25.

Pulley to Insertion	O. D.	O. S.
Superior Oblique	22.	23.

CASE VIII.

Length	O. D.	O. S.
Superior Rectus	48.5	48.
Inferior "	43.	44.
Medial "	47.	44.
Lateral "	48.	48.
Superior Oblique	52.	60.
Inferior "	27.	29.

Insertion	O. D.	O. S.
Superior Rectus	6.5	6.
Inferior "	5.	5.
Medial "	4.	5.
Lateral "	6.	6.

Superior Oblique	0 –9.	–2 –10.
(behind meridian)		
Inferior "	–3 –10.	0 –9.

Breadth of Insertion	O. D.	O. S.
Superior Rectus	10.	10.
Inferior "	9.	9.
Medial "	11.	10.
Lateral "	12.	10.
Superior Oblique	12.	9.
Inferior "	9.	10.

Globe Dimensions	O. D.	O. S.
Anteroposterior	24.	23.
Lateral	25.	25.
Vertical	25.	25.

Pulley to Insertion	O. D.	O. S.
Superior Oblique	22.	23.

CASE IX.

Length	O. D.	O. S.
Superior Rectus	65.	62.5
Inferior "	53.	59.5
Medial "	48.	52.
Lateral "	61.	61.
Superior Oblique	58.	59.
Inferior "	27.	29.

Insertion	O. D.	O. S.
Superior Rectus	8.	8.5
Inferior "	7.	7.
Medial "	5.5	6.
Lateral "	7.	8.
Superior Oblique	3 –5.	2.5 –6
(behind meridian)		
Inferior "	0 –9.	–2.5 –9.5

Breadth of Insertion	O. D.	O. S.
Superior Rectus	11.	11.5
Inferior "	11.	9.
Medial "	12.	11.5
Lateral "	9.	8.
Superior Oblique	11.5	13.
Inferior "	12.	10.5

Globe Dimensions	O. D.	O. S.
Anteroposterior	24.	25.
Lateral	24.	26.

Vertical	24.	26.
Pulley to Insertion	O. D.	O. S.
Superior Oblique	22.	25.

CASE X.

Length	O. D.	O. S.
Superior Rectus	52.	59.
Inferior "	48.	47.
Medial "	47.	49.
Lateral "	48.	47.
Superior Oblique	61.	61.
Inferior "	27.	37.
Insertion	O. D.	O. S.
Superior Rectus	7.5	8.
Inferior "	6.	8.
Medial "	6.	7.
Lateral "	7.	7.
Superior Oblique	–8. –7.5 (behind meridian)	0–9.5
Inferior "	–3.5–10.	–3 –8.
Breadth of Insertion	O. D.	O. S.
Superior Rectus	11.	11.
Inferior "	10.	9.5
Medial "	10.	10.
Lateral "	10.	10.5
Superior Oblique	10.5	12.5
Inferior "	9.	9.
Globe Dimensions	O. D.	O. S.
Anteroposterior	23.	23.
Lateral	26.	23.
Vertical	24.	23.
Pulley to Insertion	O. D.	O. S.
Superior Oblique	23.	21.

CASE XI.

Length	O. D.	O. S.
Superior Rectus		60.
Inferior "		50.
Medial "		50.
Lateral "		48.
Superior Oblique		60.
Inferior "		28.

Insertion	O. D.	O. S.
Superior Rectus		8.
Inferior "		7.5
Medial "		7.
Lateral "		7.5
Superior Oblique (behind meridian)		–2 –9.
Inferior "		–0 –9.

Breadth of Insertion	O. D.	O. S.
Superior Rectus		11.5
Inferior "		9.5
Medial "		9.5
Lateral "		9.
Superior Oblique		10.5
Inferior "		9.5

Globe Dimensions	O. D.	O. S.
Anteroposterior		22.
Lateral		22.
Vertical		22.

Pulley to Insertion	O. D.	O. S.
Superior Oblique		23.5

TABLE OF AVERAGES

Length	
Superior Rectus	54.3 mm.
Inferior "	49.8
Medial "	48.
Lateral "	52.
Superior Oblique	58.725
Inferior "	30.61

Insertion	
Superior Rectus	7.62 mm.
Inferior "	6.76
Medial "	6.09
Lateral "	7.309
Superior Oblique (behind meridian)	– .92 to –8.17
Inferior "	–1.85 to –9.75

Breadth of Insertion	
Superior Rectus	11.12 mm.
Inferior "	9.94
Medial "	10.57
Lateral "	9.81

Superior Oblique	10.95
Inferior "	9.9
Globe Dimensions	
Anteroposterior	24.24 mm.
Lateral	24.52
Vertical	24.91
Pulley to Insertion	
Superior Oblique	21.57 mm.

This study is by no means in its entirety, but will be carried on from year to year. As it is, however, a short comprehensive work in which the relations of the extrinsic ocular muscles with their measurements. All possible literature on the subject has been summed up herein. Upon any careful study into this subject the student will find literature and data upon the extrinsic muscles very scarce.

The specimens for this research were given by the anatomy department of the Ohio State University and under supervision of Prof. F. L. Landachre and Dr. R. C. Baker.

BIBLIOGRAPHY

Ophthalmology, Fuchs.
Motor Apparatus of the Eye, Stevens.
The Muscles of the Eye, Howe.
Ocular Muscles, Maddox.
Squint, Worth.
Refraction of the Eye, Donders.
Ophthalmology, DeSchweinitz.
Physiologische Optik, Helmholtz.
Zur Mechanik der Augenmuskln, Volkmann.

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THE QUESTION OF ACCOMMODATIVE CONVERGENCE*

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In the 1933 Year Book of the New York State Optometric Association, the writer published a compilation of data and analysis to support his contention that the accommodation and convergence, far from being reflexly related, should be regarded as two independent functions. In the course of the paper, he stated that the convergence should be regarded as consisting of two parts, the tonic and the fusional. He claimed that in the normal act of vision, there is no proof of the third part of convergence that is generally postulated,—accommodative convergence.

In the December, 1933, issue of the AMERICAN JOURNAL OF OPTOMETRY, a report of experiments that seems to refute our contentions was published.[1] Apparently, the report was in part an answer to our paper, for the statement is made, "While there is little question, however, as to the existence of the tonic and fusional reflexes, there has, to say the least, been some uncertainty as to the validity of the concept of accommodative convergence." The author then goes on to describe an experiment which, performed on 200 subjects, leads to the conclusion, as stated by the author: "The results would seem to uphold the concept of accommodative convergence."

The experiment consists of inducing vertical diplopia by means of prism base down before one eye, noting the lateral displacement as plus spheres are introduced before the subject's eyes. It is true that in many cases the spheres result in changes of the phoria *under these conditions.*

Please note that we put "under these conditions" in italics. One of the requisites of a genuine scientist is that he enunciate his conclusions in terms of the conditions under which the experiment is performed. Under what conditions is this experiment performed? Under conditions of forcible dissociation of the two eyes. It may be that under this condition, a pseudo-reflex reaction is produced, so that changing the accommodation by means of the spheres, changes the phoria condition. But that does not prove that the same result takes place under the normal

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*Submitted for publication December 27, 1933.

[1]Edwin Forbes Tait. A Report on the Results of the Experimental Variation of the Stimulus Conditions in the Responses of the Accommodation Convergence Reflex. Am. Jour. Optom. Vol. 10, No. 12, pp. 428-435. 1933.

and natural conditions of sight. If we may be permitted to quote from our paper: "It must be remembered that the conditions under which the reflex appears (referring to the blurring of a distant letter when prism power, base in, is introduced) are highly artificial. In fact, the phenomenon fits neatly into the category of Pavlov's 'artificial conditioned reflexes.' By his method of 'conditioning', Pavlov managed to produce reflexes in the laboratory that did not exist in the natural life of the animal. It would be fallacious to infer that because an accommodative convergence reflex was produced under the conditions of violent dissociation of the two functions, therefore, the same reflex relationship must exist in the normal use of the eyes." Again: "Testing under abnormal conditions must produce abnormal findings."

To complete the attempt to show the existence of accommodative convergence, one would have to compare the findings reported, with the phoria findings at the near point of subjects who are naturally myopic. It is safe to say, the results would not be the same. That is to say, the phoria artificially produced by 2.00 D. spheres as indicated by the high points of the distribution chart would be found to differ from the same obtained in a similar group of myopes of 2.00 D. We know from clinical experience that the phoria found at the near-point (taking the distance phoria into consideration, of course) generally shows no exact relationship with the degree and nature of the refractive error.

Again, whereas it is true that the phoria changes when spheres are introduced at the near point, this is not at all true for distance. The author of the report in fact states that no effort was made to determine the heterophoria for distance "due to the fact that the blur produced for distance by the addition of plus lenses made the judgment of vertical coincidence somewhat difficult." May we respectfully suggest that this sounds too much like special pleading, put forth for the sake of saving a theory. As a matter of fact, the blurring makes very little difference. Lateral displacement can easily be noted even though the letter looked at is very blurred—and this is true both for near and far tests. Besides, the test can be performed just as well with the Maddox rod, instead of the vertical prism. Instead of looking at a letter the subject need look only at the light. If the reader will perform the test for distance, he will find that the spheres make very little difference, if any, on the phoria finding. (The writer prefers the Maddox rod to the vertical prism test, anyway, for reasons which he has stated in another journal.)

Now, if the relationship between the convergence and the accommodation is reflex, why should not the change in the accommodation produce a corresponding change in the phoria for distance?

May we make the same criticism of the experiment reported that we did of other experiments of the same writer as published in our paper in the 1933 Year Book? To quote, "Presumably all the 500 cases had different P. D.s. Hence the amount of convergence expressed in Prism Dioptres would be different even for the same distance and phoria status.

Obviously, the only way to get a one-to-one relationship is by the use of meter angles instead of Prism Dioptres."

As to the specific results reported, to this writer, at least, they did not offer strong corroboration of any *definite* reflex relationship even under the artificial conditions noted. The findings are distributed over such a wide compass that all we can deal with is probabilities. Consider first the wide distribution of "accommodative" convergence findings at one-third of a meter with the subject's own correction before his eyes. Of the 200 subjects tested, 26 showed 18 Prism D., 23 showed 11, and the balance of the 200 are distributed in between and on both extreme ends of the chart. With the addition of 1.00 D. spheres, the most numerous group, having the same "accommodative" convergence, registered 10 Prism D. instead of the 18 Prism D. achieved by the highest group wearing merely their correction. Does that indicate that the plus spheres resulted in a change of 8.00 Prism D. in the so-called accommodative convergence? It does, if we compare the findings of the most numerous groups which show identical reactions. And yet, if we substitute instead the next largest group of those wearing only their corrections, the difference is not 8.00 Prism D. but 1.00 Prism D. It is a toss-up which group to consider as being representative, for one group consists of 26 and the other of 23. Nor does this exhaust the possible changes in the "accommodative" convergence when the plus 1.00 spheres are added, for these two groups together (26 and 23) total only 24 per cent of the entire number of subjects examined.

Decidedly the author is guilty of understatement when he says that the "relationship between the amount of accommodative stimulus and the resultant convergence reflex is not *quite* proportional." Indeed, all the experiment proves is that under conditions of forcible dissociation of the two eyes and also under conditions of artificial inhibition of the accommodation, the degree of near exophoria is increased, and the degree varies so greatly among individuals that no definite rule can be deduced, only undependable probabilities.

We humbly submit that it was unscientific for the author to have assumed the existence *a priori* of accommodative convergence. It was one of the purposes of the experiment to prove that such a thing exists. Yet the author's charts show the changes in the "accommodative convergence" when plus spheres are added. Obviously, what the charts actually recorded is simply the change in the degree of exophoria. Whether or not we can deduce from this that there is such a thing as accommodative convergence under natural conditions of sight, is another question.

Also, the author furnishes no proof or evidence for his conclusion that part of the convergence in the cases tested was found to be due to the proximal stimulus and that the average value of this part of the convergence was 5.8 Prism D. The only way in which this figure could have been arrived at was to assume that so much of the convergence *ought* to have been caused by the change in the accommodation, etc. The present writer does not claim that the proximal stimulus is not a factor,—on the

contrary. He merely notes that the experiment as reported furnished no specific data that would support the 5.8 finding.

If changes in the accommodation affected the phoria, as generally claimed, then theoretically we should be able to so markedly affect the muscle status that diplopia or near-diplopia would result. But such is not the case. The reader can judge this for himself by the following test: Let him add minus power before both eyes in the phorometer while he looks off at a distant letter. At no time will there be any suggestion of diplopia, even with an excess of 10.00 spheres before the eyes. The same with plus spheres. The test holds true for the near point as well.

Again: we know that aphakic individuals or individuals having a complete paralysis of accommodation may have a normal amplitude of convergence. No part of the convergence in these cases is furnished by the accommodation.

Once more: assuming that the exophoria produced by plus spheres at near operates under normal conditions of sight, we would expect that introducing the plus spheres would alter the maximum prism power base out before both eyes that the individual can overcome and still maintain fusion at the near point. Yet this is not so, as the reader can determine for himself by means of rotary prisms. One would expect in this case that more prism power could be overcome without the plus spheres than with them, owing to the fact that with the latter a greater amount of exophoria would have to be overcome.

So that there may be no misunderstanding of the present writer's position, he wishes to repeat what he stated in the Year Book: he agrees with Dr. Alexander, British ophthalmologist, that innervational impulses from the convergence centers may be reflex from the retina. That is, the desire for single binocular vision may be weakened by a blurring of the retinal images and increased when they are made clearer, with resultant modification of the activity of the rotators. We admit the possibility of a reflex—but from the retina, not from the accommodation. We believe that this reflex can explain most of the phenomena occurring under normal, natural conditions of sight that seem to be explainable only on the basis of an accommodation-convergence reflex.

And we reiterate our claim originally promulgated by us in these pages in 1930 that it is unnecessary to presuppose the existence of accommodative convergence or convergence accommodation under natural conditions of sight,—that on the contrary such a presupposition leads us astray in our calculations, and that it is not based on scientific evidence.

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A CASE OF TOTAL MONOLATERAL BLINDNESS TREATED SUCCESSFULLY WITH THE USE OF PHYSICAL AGENTS*

J. I. Kurtz, B. S., A. O., F. A. A. O.
Minneapolis, Minn.

I am reporting this case for Dr. Ray V. Jones, of San Diego, California, a Fellow of the Academy. It is a very unusual and interesting case.

Miss R. E., age 13, was brought to him for examination October 14, 1931. She was examined before at the school clinic and the ophthalmologist diagnosed her case as complete blindness of the right eye and partial blindness of the left and in order to save the remaining sight in the left eye he ordered the child placed in the sight saving class, at the Lincoln School in San Diego. The nurse told the child's mother that an education would do her no good. She must have special training. Glasses were prescribed for her: O. D. plano, O. S. —0.50 D. Sph.

Dr. Jones gives the following information about the case.

History. "Indigestion, extremely nervous and irritable, anemic, restless at night, tires quickly, frontal and occipital headaches, frequent colds, photophobia, undernourished, weight 71 pounds, underweight. Diagnosed at school clinic totally blind O. D. and probable blindness later in O. S., taken out of regular school and placed in class for blind.

"Visual Acuity before treatment—O. D. perception of very bright light at two inches. O. S. 20/40.

"Static Skiascopy before treatments—O. D. + 0.50 D. Sph., O. S. neutral.

"Static Skiascopy after treatments—O. D. + 0.25 D. Sph., O. S. + 0.25 D. Sph.

"Dynamic Skiascopy before treatments—O. D. + 1.00 D. Sph., O. S. + 1.25 D. Sph.

"Dynamic Skiascopy after treatments—O. D. + 1.25 D. Sph., O. S. + 1.25 D. Sph.

"She had been in sight saving class *four months.* Treatments were started the 16th of October, 1931. About thirty minutes were

*An abridgement of the material presented before the American Academy of Optometry at Chicago, December 18, 1932.

devoted to each treatment, ten minutes massage and twenty minutes electricity. Patient has been given in all 13 treatments."

Date of Treatments	Type of Treatments	Results After Treatments
Oct. 16, 1931	H. F. & Massage	Good co-operation from patient.
Oct. 23, 1931	" "	Feels better.
Oct. 30, 1931	" "	Headaches gone, less nervousness, more energy.
Nov. 3, 1931	Auto Condensation	Gaining in weight. Indigestion gone.
Nov. 6, 1931	H. F. & Massage	Mother says she seems like a different child.
Nov. 13, 1931	Auto Condensation	V. A. O. D. 20/300.
Nov. 27, 1931	" "	" " 20/300.
Dec. 1, 1931	H. F. & Massage	" " 20/80.
Dec. 4, 1931	" "	" " 20/40. O. S. 20/40.
Dec. 8, 1931	" "	" " 20/20.
Dec. 11, 1931	" "	" " 20/20. O. S. 20/20. O. U. 20/15.
Dec. 15, 1931	Auto Condensation	" " 20/20. O. S. 20/20. O. U. 20/15.
Dec. 18, 1931	H. F. & Massage	" " 20/20. O. S. 20/20. O. U. 20/15.

"Eye massage with fingers while indirect high frequency current was passing. The modality relied upon and used to the greatest extent was indirect high frequency. Using the auto condensation pad and either vacuum electrode or fingers over closed lids.

"I might add that some opposition was displayed by some of the school examiners. I have been very rigidly checked on ever point by the medical examiners. The case was given a thorough check December 16th, 1931, and pronounced by them absolutely normal. They were quite surprised to find a blind eye registering 20/20. This case has certainly registered the word Optometry on a number of the school officials.

We should have more information about this case before an intelligent interpretation could be made, however, from the information Dr. Jones did supply me, I am inclined to think that this is a case of *functional blindness.* I know of no type of blindness of an organic nature which would yield to treatment so readily and regain normal vision in such a short treatment period.

Searching the literature on the subject I find: Janet in his book the "Major Symptoms of Hysteria" tells of an incident where a man as the result of a trivial injury became blind and remained so for four years.

In another case a woman was struck in the face with some soapy water while working in a laundry, her face was slightly burned, but none of the water penetrated her eyes, in spite of this she became completely blind for two years.

It is possible that the blindness in the case of the girl reported by Dr. Jones is the result of some such accident as mentioned by Janet, and is a condition of functional blindness. The suddenness of recovery is a strong point in favor of this contention.

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AMERICAN JOURNAL OF OPTOMETRY

Vol. 11 FEBRUARY, 1934 No. 2

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Original papers, scientific communications, clinical reports, society proceedings, books for review, and correspondence should be sent to the Editor, Dr. Carel C. Koch.

Annual Subscription, $4.00 in Advance, Canada and Foreign, $5.00.
Single Copies, 40c.

Copy of advertisements must be sent in by the tenth of the month preceding their appearance. Subscriptions, applications for single copies, communications with reference to advertising or other business should be addressed to the Business Manager, Dr. Jack I. Kurtz, 1501 Foshay Tower, Minneapolis, Minn.

Published Monthly by the
American Journal of Optometry Publishing Association.

The Journal has no objection to the reprinting by other magazines of any of its articles, provided such reprints are properly credited to the American Journal of Optometry.

CONTACT EYE-GLASSES

The subject of contact eye-glasses is not, in the writer's opinion, taken as seriously as it should be by optometrists in America. To many the prescribing of them is an unknown procedure and to most of the others it is merely an abstract thing—a sort of an experimental idea to be carried out only in some faraway outlandish place by people not of our sort. In holding these views we prove ourselves to be decidedly provincial and in the broadest sense of the word also prove ourselves to be very much behind-the-times.

In continental Europe, due to the careful work done in this field by certain ophthalmologists and by the technical staff of the Carl Zeiss works at Jena, Germany, the matter has progressed far beyond the experimental stage. Contact eye-glasses are now being successfully prescribed and worn as a matter of routine procedure.

In America, on the other hand, we find in reviewing optometric literature that but one optometrist has made any contribution to our knowledge of these new and valued refractive technics. This optometrist is William Feinbloom of New York City. Feinbloom, admittedly one of the most advanced thinkers of our profession, has prescribed these contact eye-glasses in certain of his cases with very satisfactory results.

Case reports, dealing with this work, published in this JOURNAL[1], indicate that his cases can use these contact eye-glasses with comfort for periods varying from two to four hours at a time. As many of these patients have but little vision without these aids, it becomes, therefore, obvious that their use is of great value indeed.

Professor Southall of Columbia University, writing of Dr. L. Heines' works in the field of prescribing contact eye-glasses has this to say on the subject:[2] The improved form of contact eye-glass, which is the result of careful and painstaking experimentation, is a thin glass shell, accurately ground and polished on both surfaces, the outside diameter being about 2 cm. Not more than half a gram in weight, it is intended to be inserted under the eyelids over the exposed outer part of the eyeball, being held firmly in place partly by the adhesion of a film of tear fluid or artificial salt solution which forms a connecting liquid medium between the cornea of the eye and the inner surface of the optical zone of the contact eye-glass. Thus without coming directly in contact with this sensitive membrane, the shell is attached to the eyeball and turns freely and easily with it, which in itself is one of the natural advantages of this device as compared with ordinary spectacles. Another advantage is that these eye-glasses are practically invisible and, so far from being disfiguring, are more apt to be comely and pleasing in appearance than otherwise. Made of a single piece of glass, the shell really consists of two parts, a central optical zone of from 8 to 12 mm in diameter which bulges out slightly over the cornea and a surrounding annular portion which fits lightly and snugly over the selera of the eye and is of no optical consequence at all.

The practical effect of a contact eye-glass in actual use is to annul the refraction of the cornea almost entirely and, so to speak, to substitute a more or less perfect optical surface in place of the anterior surface of the cornea which is sometimes so uneven and irregular (as in keratoconus or conical cornea) that distinct vision is absolutely out of the question. Dr. Heine alludes to the case of a clergyman who was one of his patients and nearly blind. The prescribed contact eye-glass had been inserted in his eye without his knowing it and such was his astonishment on opening his eyes and finding that he could discern clearly the objects around him and the faces of the attendants that he believed a miracle had been performed.

According to Dr. Heine the following are some of the main advantages of contact eye-glasses as compared with ordinary spectacles: (1) Improvement of visual acuity in high myopia, irregular astigmatism (keratoconus) and aphakia: (2) Enlargement of field of view of the

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[1]William Feinbloom. Contact Glasses. American Journal of Optometry. Vol. 9, No. 3, pp. 78-111. 193

[2]J. P. C. Southall. Review of Scientific Instruments. Vol. 5, p. 54. Jan., 1934.

immobile eye and of the field of fixation of the mobile eye; (3) Improvement of stereoscopic vision (binocular depth perception); and (4) Convenience, safety and inconspicuousness.

Professor Southall also claims that contact eye-glasses seem to have an assured future and one day they will undoubtedly be used more extensively than now, not only for correcting irregular astigmatism and the more serious defects of vision but for ordinary purposes in many cases where spectacles are used at present. —C. C. K.

CORRESPONDENCE

THE FUNDAMENTALS OF OPTOMETRIC EDUCATION*

A short time ago there was sold to a group of Philadelphia optometrists an extension course of study that offers instruction and material via the mails. If I remember correctly, thirty-five optometrists promised to pay something like seven hundred dollars for four books and question and answer material, and the suggestion was made that the material be gone over and studied by the several optometrists.

I am entirely in sympathy with the idea that optometrists further their professional knowledge and skill by study. I have therefore tried to ascertain if such a plan of study is practicable or feasible. And I have reasoned pretty much as follows:

The fundamentals of optometry, as I know them, are:

Mathematics, involving a ready facility in the theory and application of algebra, geometry, and trigonometry. Some knowledge of the elementary facts of the calculus is desirable, but not indispensable, in dealing with, and understanding, the principles of theoretic optics.

Theoretic optics, and the physics of light, which are the foundation stones of refraction. Without these fundamentals, the behavior and proper interpretation and control of light by mirrors, prisms and lenses cannot be had. Accurate instrumentation is impossible without them. Without them, the refractionist is really a pseudo-optometrist. This study, unless augmented by laboratory experiments, leaves too much to the imagination as to what the facts are.

Physiologic optics, which is a deeply intricate study, and without which the practise of optometry becomes a mere adaptation of lenses of the hit-or-miss variety of gone-by days. This is really the control subject of optometry, a field of not a few valuable facts, and of much fine, provocative conjecture given by the most astute, yet cautious, scientific minds of the world in historic scientific time.

*Received January 5, 1934.

Finally, there are, as fundamentals of a well-rounded education in optometry, general and particular, normal and abnormal anatomy, physiology, genetics and psychology.

Sub-fundamental is all the knowledge that can be absorbed relating to the inter-dependent sciences.

I am perfectly willing to confess that twelve years after leaving school I am still working on the fundamentals, and I expect to continue to work on the fundamentals for many years to come. I never rated as an especially gifted student, so my complete grasp of fundamentals must necessarily be slow. However, I am of the firm opinion that the acquiring of scientific knowledge by any other than an orderly course of study is dangerous, if not disastrous. Confusion and distrust, and, finally, abandonment are the result.

How much worse, then, is it to acquire as knowledge the unauthoritative opinions or theories of highly imaginative people woven into the culled scientific facts gained by authorities? The attempt to prove a single scientific fact from reasonable theory has been the complete life-work of great authorities. One is humbled by the exhaustive work, under terrible handicap, of such a man as Weissman, of Breisgau University to prove or disprove that an acquired characteristic may not be transmitted as an hereditary trait. The evidence of their works has checked my own early tendency to enthusiastic imagination. Where the scientist advances a theory with the greatest caution, the pseudo-scientist announces his theory as proven by facts. And I am very much afraid that we optometrists have absorbed into our system many fictional theories unsupported by any truly scientific experiments and analyses, coupled with a few, tiny grains of old and borrowed facts, the latter so fogged and disguised by masses of trash as to be almost undiscoverable or recognizable.

Therefore, it seems to me that optometrists who are anxious to gain knowledge and become better informed and better equipped practitioners, ought first to make sure of their fundamentals. And, if the facts sought are not had as fundamentals, I still insist that they go to the authorities. I mean by authorities those men who are held pre-eminent in their respective life-work by their peers.

We have a college in Philadelphia presumably manned by competent instructors who can teach fundamentals. If their services cannot be had, then my urgent advice is to get a private tutor. And if that is impossible, I would carry on the work at home by reading and studying the recognized and honored works of Andrew Jay Cross and Charles Sheard, a good, standard work in physics; any of the good elementary works of mathematics; such works as Huxley's physiology, as well as all of his writings you can get; both of the works of Tscherning and Helmholtz, and all of Helmholtz' writings you can get; Southall's "Mirrors, Prisms and Lenses"; all of the writings of William James you can absorb; and Newman's work on genetics. The literature on abnormal psychology should be most informative and helpful.

In Philadelphia, our optometrists are favorably situated with respect to an optometry college of standing, and ought to be guided and taught to maximum advantage in their own school. Men who enroll in the extension, or correspondence school, tacitly condemn their own school and its able faculty as unable to provide the material they need to make them better optometrists.

My own conclusions are that the extension courses proferred, no matter how well-meaning, must prove fruitless except as a pleasant engagement of the imagination, or a game of trying to sift the false from the true, if that is at all possible. I fear the mixture of unauthoritative theory with fact will lead to confusion, distrust and abandonment, and is therefore fraught with danger to the welfare of optometry. If the work has genuine merit, my criticism can do no harm. But, before optometrists spend their good dollars and valuable time that could be harnessed in a better, directed effort, it (the work) ought to stand the critical approval of men like Frederic Woll, Charles Sheard, James P. C. Southall, and other distinguished teachers who are primarily interested in the imparting of true knowledge.

W. H. GLAZER

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BOOK NOTICES

TRANSACTIONS OF THE OPTICAL CONGRESS, 1933. Edited by W. E. Hardy. Published by the Hatton Press, Ltd., 72 Fleet Street, E. C. 4, London England. 53 pages. Illustrated. 3s. 6d. Postage 3d. extra. 1933.

The 1933 Optical Congress was one of the largest and most important gatherings of ophthalmic opticians ever held in England. During this congress some fourteen talks were made by members of the profession and to place these talks on record it was decided to publish this book containing most of these addresses in full along with whatever important discussion followed each talk.

Of the material in this volume five papers are worthy of mention. The first of these is by E. W. Woodruff, B.Sc., F.B.O.A. (Hons.) dealing with the Optics of Contact Glasses. The second paper is one on Modern Refractive Technics by G. W. Colebrook, F.B.O.A. (Hons.) This paper mentions a number of technics but little used in the States and is very nicely written. The third important paper in this volume deals with the Treatment of Strabismus and is written by W. Green, F.S.M.C. The fourth paper is on the same subject and is

written by H. B. Marton, F.B.O.A. (Hons.) Marton is familiar to readers of this JOURNAL as several of his papers have appeared in these pages. Both of these papers on Strabismus are nicely done. The fifth and most important paper in the book is one on Myopia written by R. L. Sutcliff, who in a relatively short manuscript covered the subject very ably and thoroughly.

It is hoped that this small volume will have a wide distribution as much of real interest is contained therein. —C. C. K.

* * * * *

PHYSICAL OPTICS. Robert W. Wood, Ph.D. Professor of Experimental Physics in the Johns Hopkins University. Published by the Macmillan Company, New York City. 846 pages with full index. Illustrated, $7.50, 1934.

This book, as did the two preceding editions, deals with the laboratory experimental side of physical optics. Wood has taken great care in reviewing in detail the experimental technics employed in making the physical investigations on matter to which he has dedicated his life.

As there has been much change in the theories of optical phenomena since the last revised edition much of the old work has been replaced with new and several entirely new chapters on the origin of Spectra and on Magneto- and Electro-Optics have been added.

For the physicist, the laboratory research worker and the students of physics and physical optics this work is a reference book which covers these subjects very thoroughly, dealing as it does with the underlying laws of nature and in every instance presenting the most advanced theories as to the application of these laws. For the busy practitioner of optometry there is little of value in this work but for that small but important section of optometric men interested in research work this book will present much of the newer matter in a concise manner.

—C. C. K.

* * * * *

ANIMATED FUSION TRAINING CHARTS. (A set of 101 colored charts in heavy paper box) by Dr. Israel Dvorine. Published by the Animated Fusion Training Charts Company, 2328 Eutaw Place, Baltimore, Maryland. Distributed through the American Optical Company. $10. 1933.

Dvorine has devised a set of Fusion Training cards in which motion has been added to colored drawings to stimulate interest on the part of squint patients whose treatment has developed to the point of using the stereoscope to develop fusion.

These charts are the first to my knowledge to make use of motion to stimulate visual attention. This is obtained through movement of

discs attached to the charts. A slight downward pressure on the exposed part of a disc by the optometrist or, better still, by the patient himself under the direction of the doctor, causes the disc to rotate and bring a new view before the squinting eye. The charts are numbered and are to be used in certain series as the case improves. Dvorine has added something of real value to these stereoscopic charts, which must be seen and used to be fully appreciated. —C. C. K.

* * * * *

ANATOMICAL VIEWS. By Dr. Chas. Gustrine, 5508 Washington Blvd., Chicago, Ill. Three life size views. 1933. $1.50.

Dr. Gustrine presents the ocular and facial anatomy and neurology in three life size portraits mounted in a folder. One is a front view, the other is a right lateral and the third a left lateral view. These views furnish a quick and easy means for any optometrist for reviewing the anatomy and neurology of the parts he is most interested in.

It is to be hoped that some day Dr. Gustrine will work out a chart in colors which will represent the two eyes, their muscles and nerves which could be used by the optometrist to explain to his patient his ocular and muscular abnormalities. There is a definite need for such a chart. —J. I. K.

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